Characteristics of Electrodeposited $Ni(OH)_2$ Electrode for a Hybrid Electrochemical Capacitor

Jong-Huy Kim, Yong-Sung Lee, Chang-Soo Jin

Energy Conversion and Storage Research Center
Korea Institute of Energy Research
71-2 Jang-dong Yousung-gu, Daeduck Science Town,
Taejeon, 305-343, KOREA
e-mail: kjhy@kier.re.kr

For hybrid types of electrochemical capacitors, in which positive and negative electrodes have different active materials and capacitance principles, a mass balance of active materials between the two electrodes is necessary to optimize the cell characteristics of working voltage range, specific capacitance, and also ESR. Mostly, of the hybrid electrochemical capacitors, the positive electrode has a redox dependant capacitance and so its specific capacitance and resistance are larger than the electric double layer capacitance dependant negative electrode has.

In this study, for the positive nickel hydroxide electrode of a hybrid capacitor which was expected to have a higher specific capacitance but with a lower resistance, by using 0.1M $Ni(NO_3)_26H_2O$ solution at pH 4.27, electrodepositions of $Ni(OH)_2$ on 50 μm thickness of nickel foil and 200 μm thickness of pressed nickel form current collectors were conducted. In any processes of electrodepostions, neither conductors nor binder materials were added to.

Variations of deposited $Ni(OH)_2$ weight per a projected electrode area were examined at different deposition current densities from 0.5 to 5.0 mA/cm^2, total amount of charges with 1800 and 5400 mC, and deposition time up to 900 minutes. From XRD spectrum analysis, phase changes of deposited $Ni(OH)_2$ from α(II)- to β(II)-$Ni(OH)_2$ by aging in 6M KOH for 6 to 48 hours were confirmed as in Fig. 1. Based on CV curves and SEM/TEM photographs, it was known that the aged $Ni(OH)_2$ electrode had higher specific capacitance and became more porous.

From this study, it was found that the electrodepostion on the pressed nickel form was effective to sustain a mechanical strength of the deposited $Ni(OH)_2$. Possibly lower current density in the deposition and longer aging time over 12 hrs were effective to make the deposited $Ni(OH)_2$ particles more smaller nano-size(see Fig. 2) and higher porosity so as to obtain higher specific capacitance(see Fig.3). Comparing with non-aged α(II)-$Ni(OH)_2$ electrode, it was noted that the β(II)-$Ni(OH)_2$ electrode after 24 hrs aging had faster consistencies of cathodic and anodic peak potentials after about 10 and 20 cycles in CVs with 10mV/sec of scan rate respectively. Also, the aged electrode showed higher peak currents and potential deviations between cathodic and anodic peaks.

Acknowledgement : This study was financially supported by Korean Ministry of Science and Technology(MOST) based on the National Lab Research (NRL) program and Korean Institute of Energy Research(KIER).

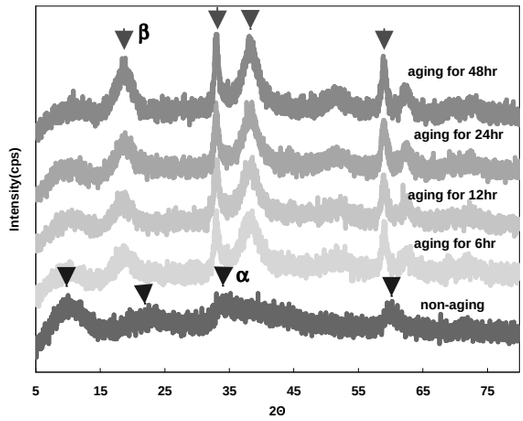

Fig. 1. XRD spectrum for non-aged and aged $Ni(OH)_2$.

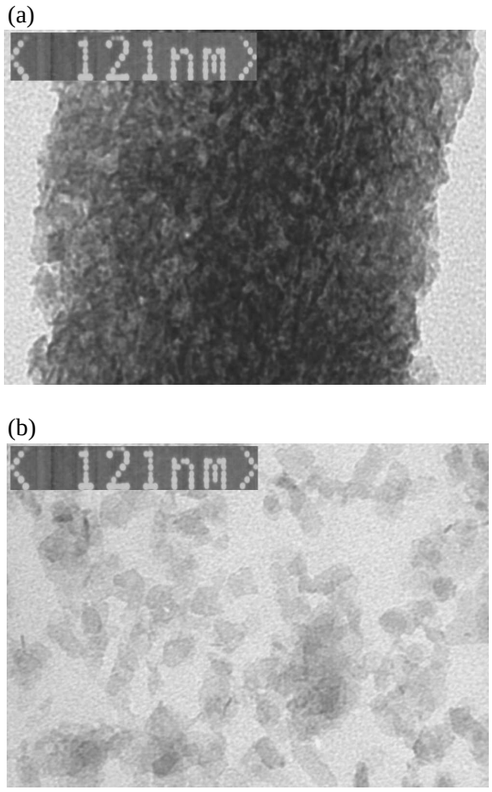

Fig. 2. TEM images of (a) non-aged α(II)- and (b) aged β(II)-$Ni(OH)_2$ particle for 24hrs in 6M KOH.

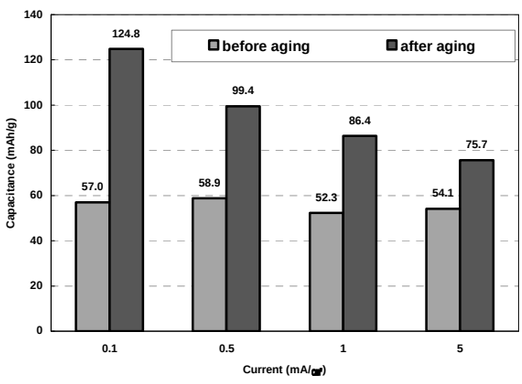

Fig. 3. Capacitance increments for the $Ni(OH)_2$ electrodes deposited in different current densities.